Part Three:
Optional Gypsum Blocks Protocol

Advanced Students

Purpose

To monitor soil water content indirectly in a column or depth profile of soil.

Time

5 minutes per day, though the initial calibration will take more time.

Level

Advanced

Frequency

Daily

Key Concepts and Skills

Concepts

A soil moisture meter can be used to make an indirect measurement of soil water content after calibration.

Skills

Properly *using* a balance and soil moisture meter

Calibration

Recording and *analyzing* data

Materials and Tools

GLOBE Science Notebooks
five cm soil auger
an old screwdriver or kitchen knife to remove soil from auger and to mix mud
a meter stick to measure the depth of your hole
four soil cans
four gypsum blocks
4 x 10 cm long x 7.6 cm diameter PVC pipe or tin cans for hole guides at the surface
four small cans (or tin cans) to cover the PVC pipe
adhesive tape and pens to label cans and PVC
two four-liter (mixing/holding) buckets
one quart of water for mixing mud
one meter long x 2 cm PVC guide tube
tapping stick (broom handle)

Preparation

Select your site and install the gypsum blocks according to the following protocol.

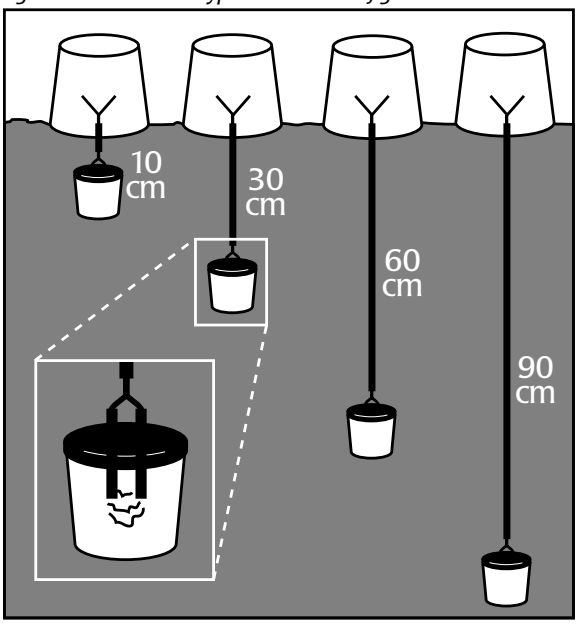
Prerequisite

Establish the Atmosphere Study Site

A. Installation of gypsum blocks

1. Place the gypsum blocks into a container of water and allow to soak for 5 minutes.
2. Auger a hole to the appropriate depth for each gypsum block sensor (10, 30, 60 and 90cm). A soil auger works like a cork screw – simply lean on the handle as you turn it. It is best to remove the auger bucket from the hole after several turns and clean the soil out of the bucket. If you fill it too full, it will be very difficult to remove the soil. Place the extracted soil in a large pail to keep the site clean. The four holes should be placed next to one another in sequence to reduce potential confusion while taking readings and recording data.
3. Put one or two large handfuls of the soil extracted from the hole into a small bucket or similar container. Add a small amount of water and stir to create a mudball. The mudball should stick together. Remove any rocks.
4. Drop the mudball to the bottom of the hole. Make sure it reaches the bottom.
5. Place the wire lead from one of the sensors through the PVC guide tube.

Figure 5-10: Installed Gypsum Blocks Configuration



6. Grab the end of the lead and pull the sensor up tight against the end of the pipe. Lower the sensor into the hole while holding it against the end of the pipe. Holding the wire lead tightly at the top of the pipe, gently push the pipe down to seat the sensor in the mud at the bottom of the hole.

   Note: Since it is difficult to pack soil tightly around the sensor, the purpose of the mud is to establish good contact between the sensor and the soil particles.

7. Hold the sensor in place with the pipe while you begin to backfill the hole. Add just a few handfuls of soil and gently tamp with a broom stick or similar pole. Then add a little more soil and remove the pipe as you tamp. Continue adding soil a few handfuls at a time and tamping firmly as you backfill the hole. Hold on to the wire lead as you backfill so that it will come straight to the surface.

8. After the hole is filled, it is a good idea to place a short piece (about 10 to 20 cm long) of PVC pipe, tin can, or coffee can (with the top and bottom removed) around the wire lead to protect it and make it more visible to anyone walking in the vicinity.

   a. First, label the pipe or can with the appropriate sensor depth.

   b. Put the wire through the pipe or can and press the pipe or can 2 to 5 cm into the soil to keep it in place. Do not cut the wire, but wind up the free end extending out of the ground and place it in the pipe or can to keep it out of the way between measurements.

   c. Repeat the above steps for each sensor.

9. A small empty can (soup, etc.) should be inverted over the end of the PVC pipe to keep the rain out.

The sensors will require about one week to settle before measurements should be considered relevant. The wire leads are fragile, especially where they connect to the meter. If the end of the wire leads to the gypsum blocks break, peel back the wire insulation and make new leads. It is important to leave enough wire above the ground for this.

B. Reading the Soil Moisture Meter

Congratulations! Your gypsum blocks are installed. Wait at least one week before beginning to take data which you report to the GLOBE Student Data Archive. After this, monitor your gypsum blocks daily for soil moisture variations. This is the fun and easy part of this investigation. Do not monitor the blocks when the ground is frozen.

Materials and Tools

GLOBE Science Notebooks
Soil-moisture meter

Preparation

Test the soil-moisture meter to ensure it is functioning properly according to the manufacturer's instructions. Do this before each use.

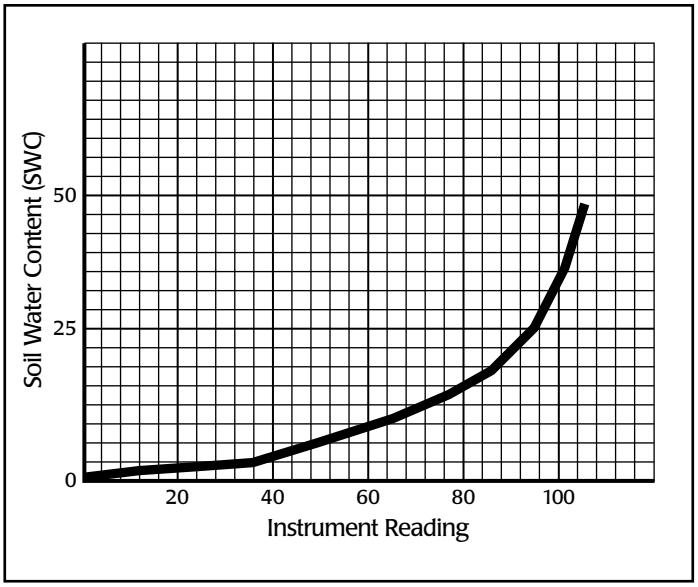
How to Make a Soil Moisture Reading

1. Obtain the reading for each gypsum block.

   a. Connect the soil-moisture meter to the wire leads of the gypsum block located at the 10 cm depth.

   b. Push READ button. Wait for the meter to reach a constant value – it should not be negative.

Figure 5-11: Example of a Gypsum Block Calibration Curve



30 cm

Date	Reading	SWC
2/4/95	42	7
2/5/95	17	3
2/6/95	100	35
2/7/95	91	25
2/8/95	70	14

c. Record the date, time, depth and value.

d. Disconnect the meter and store the wire leads.

e. Replace the cover over the PVC pipe.

f. Repeat a - e for each of the remaining gypsum blocks (30, 60, 90 cm).

2. Report all four meter readings to the GLOBE Student Data Server.

3. Convert each meter reading to soil water content as in part D below.

C. Calibration of Gypsum Blocks

The gypsum blocks must be calibrated so that the meter reading you make can be related to soil water content (SWC). This process can take 6-8 weeks, depending upon how quickly your soil moves through its full drying cycle. Rather than calibrate your gypsum blocks at every depth, we have adopted a policy of basing each calibration on observations made from the 30 cm sensor. Technically, this assumes your soil profile is uniform and your gypsum blocks are identical. It takes about 30 minutes to complete the steps below.

Materials and Tools

GLOBE Science Notebooks
Five cm Soil Auger
Old screwdriver or kitchen knife
Metric ruler
One or two soil collection cans

The materials for the Soil Moisture Protocol are also needed

Protocol

1. Acquire a soil meter reading for the 30 cm gypsum block sensor.
2. Select a random location within 5 m of the 30 cm gypsum block sensor.
3. Clear surface debris.
4. Auger to 30 cm and collect a 100 g sample centered at this depth. Place the soil sample in a soil can and number the can.
5. Backfill the hole and replace the surface cover.
6. Record the date, time, depth and can number.
7. Now repeat Task B of the Soil Moisture Protocol.
8. Record the date and time (in Universal Time) of your measurement, the three weights and the soil moisture reading that you obtained.

9. Repeat steps 1 - 8 about twenty times as the soil moves through one or two complete drying cycles. Wait until your meter reading changes 5% before collecting another gravimetric sample.

D. Creating a Calibration Curve

1. Complete the Optional Gypsum Blocks Protocol Calibration Data Work Sheet by using the following to calculate the values for Soil Water Content for each row of the Work Sheet.

$$100 \times \left(\frac{\text{wet weight - dry weight}}{\text{dry weight - can weight}} \right) = \text{soil water content}$$

Remember:

wet weight = wet soil + can + lid

dry weight = dry soil + can + lid

2. Create a graph in which you plot the just-calculated soil water content on the Y-axis and the soil-moisture meter reading value on the X-axis.

You should now have created a calibration curve, through a broad range of soil moistures, which you will use to convert future meter readings to soil water content.

If you have any questions about creating your calibration curve or you need any assistance with the curve, Dr. Washburne, the principal investigator for the Soil Moisture Investigation, is glad to provide answers and assistance. You can contact him by phone, fax, e-mail or conventional mail at:

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When you have finished determining your calibration curve, please mail or fax a copy of your curve and of your Optional Gypsum Blocks Protocol Calibration Data Work Sheet to Dr. Washburne at the above address.

During the year, if you get readings either higher or lower than any of the readings on your Data Work Sheet, take a gravimetric sample following the steps in part C of this protocol and use the values you measure for this sample to extend your calibration curve. Again, please send a copy of your revised calibration curve and extended Optional Gypsum Blocks Protocol Calibration Data Work Sheet to Dr. Washburne.